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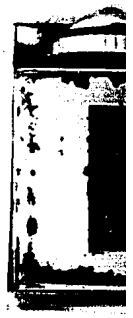

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ELECTRIC POWER PLANTS IN SERBIA

[The following report on electric power plants in Serbia describes the postwar plan for power plant construction, the plants enlarged and put into operation, the installed and distribution capacity of power plants, the high-voltage transmission lines, the production of power, the costs of electric power, and the consumption of electric power. Included are detailed descriptions of two power systems under construction, the Vlasina system and the Zvornik Hydroelectric Power Plant. The report also presents a criticism of the shortage of electric power in Serbia.

Numbers in parentheses refer to appended sources.

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Plan for Power Plant Construction

The postwar plan for the development and construction of electric power plants in Serbia calls for the construction of plants with a total capacity of 308,200 kilowatts, 193,700 kilowatts of which are to be supplied by hydroelectric power. The combined output of new plants is planned to total more than one billion kilowatt-hours; hydroelectric power capacity alone is to be increased to about 700 million kilowatt-hours. The plan is not expected to be fulfilled before 1955 or 1956.

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The plan calls for the following power plants to be constructed:

Hydroelectric Power Plants

Power Plants	Installed Capacity (kw)	Time of Completion or Initial Operation	Potential Annual Production (1,000 kw-hr)
Zvornik	84,000	Completion of: First and second generator units in 1953 and 1954 (two additional units in 1956)	400,000
Vlasina: Vrla I	21,000	Two generator units in 1953 and 1954	40,000
Vrla II	22,400	Two generator units in 1953 and 1955	30,000
Vrla III	25,000	Two generator units in 1956 and 1958	40,000
Vrla IV	22,400	Two generator units in 1957 and 1959	40,000
Raska	6,000	1953	28,000
Ovcar Banja	4,600	Two generator units in 1953 and 1954	20,800
Medjuvrsje	4,600	Two generator units in 1953 and 1954	20,800
Sokolovica	2,300	Initial operation: 1951 [number of units to be put in operation is not indicated]	6,000*
Seljasnica	900	1952	500*
Sokolja	500	1951	1,000*
Total	193,700		

*According to plan for 1952.

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Thermal Power Plants

Power Plants	Installed Capacity (kw)	Time of Completion or Initial Operation	Potential Annual Production (1,000 kw-hr)
Veliki Kostolac	42,000	Three generator units at the beginning of 1952 and the fourth in 1953	200,000
Kolubara (Vreoci II)	50,000	Two generator units in 1955	300,000
Kosovo	2,500	1953	10,000
Zrenjanin (Toplana)	20,000	End of 1952	58,300
Total	114,500		568,300 (1)

[The 11 October 1952 issue of Duga (Rainbow), a weekly periodical published in Belgrade, reports the following information on the above plants:]

The following hydroelectric plants have been completed: the Sokolovica plant near Zajecar, which has a capacity of approximately 2,600 kilowatts and an annual production of 5 million kilowatt-hours, and the Seljasnica plant at Prijepolje, which has a capacity of approximately 500 kilowatts and an annual production of approximately 2 million kilowatt-hours.

The following hydroelectric plants are under construction: The Zvornik plant, in Mali Zvornik, will have two generator units with a capacity of approximately 42,000 kilowatts and an annual production of approximately 180 to 200 million kilowatt-hours. It is to be in operation by the end of 1954.

The Vrla I and Vrla II plants of the Vlasina power systems are to be in operation in early 1954. They will have two generator units with a total capacity of approximately 21,000 kilowatts [22,000 kilowatts according to sources] and an annual production of 80 million kilowatt-hours.

The Raska plant near Novi Pazar, with two generator units of 3,000 kilowatts each, will have an annual production of approximately 45 million kilowatt-hours.

In its first state of operation the Ovcar Banja plant will have a capacity of approximately 3,000 kilowatts and an annual production of approximately 25 million kilowatt-hours. In the second state of operation after 1954, the plant will have a capacity of approximately 3,000 kilowatts and a total annual production of 30 to 35 million kilowatt-hours.

In its first stage of operation, the Medjuvrsje plant near Cacak is to have a capacity of approximately 3,000 kilowatts, and a similar capacity in its second stage of operation after 1954. The total annual production is to be approximately 30 to 35 million kilowatt-hours.(2)

The "Ras" [Raska] Hydroelectric Power Plant, completed in July 1953, is located at the source of the Raska River near the Monastery of Sopocani. The "Ras" is an important source of power both for the Sandzak and neighboring regions of Serbia. The current installed capacity is 8,500 horsepower; the annual production is to be 23 million kilowatt-hours.(3)

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Plants Enlarged and Put Into Operation

In line with the capital construction plan and domestic requirements for power, it has been necessary to achieve maximum utilization of domestic reserves of electric power and to rebuild existing capacities. Between 1945 and the end of 1951, the following power plants were enlarged: the thermal power plants in Novi Sad, Leskovac, Nis (Crveni Krst), Cuprija, Vrecci, and Subotica; and the hydroelectric power plant in Vucje. During the same period the following plants were put into operation: the thermal power plants in Zvezdan, Mali Kostolac, Veliki Kostolac, and Titovo Uzice; and the hydroelectric power plant in Sokolovica.

Installed and Distribution Capacity of Power Plants

At the beginning of 1952, the total installed capacity of Serbian electric power plants was 225,453 kilowatts, or an increase of 48,137 kilowatts over 1951. Installed capacity was distributed by type of power plant as follows: hydroelectric power plants, 4.52 percent; thermal power plants, 87.93 percent; gas combustion plants, 1.83 percent; and fuel oil plants, 5.72 percent. The distribution capacity of Serbian electric power plants at the beginning of 1952 totaled 184,793 kilowatts.

At the beginning of 1952, the total installed capacities of Serbia constituted 25.75 percent of the total installed capacities of Yugoslavia, while Croatia's capacities constituted 30.14 percent and Slovenia's, 2[illegible] percent.

At the beginning of 1952, electric power capacities were distributed throughout Serbia as follows:

	Total for Serbia	Serbia Proper	Vojvodina	Kosmet
No of power plants	226	133	73	20
Installed capacity (kilowatts)	225,453	[illegible]	50,811	19,053
Percent of participation	100	73.54	18.11	8.45
Distribution capacity (kilowatts)	184,793	139,324	30,730	15,739
Percent of participation	100	74.97	16.63	8.5

The number of kilowatts per 1,000 population was as follows:

Installed capacity	33.56	39.15	23.92	18.01
Distribution capacity	27.51	32.71	18.01	20.13

The distribution of installed and distribution capacities according to purpose of power plant was as follows:

Consumer	No of Plants	Installed Capacities (kw)	Distribution Capacities (kw)	Distribution Capacities (%)
Public				
In the system	38	120,410	106,730	88.63
Outside the system	105	13,040	11,134	85.37
Total	143	133,450	117,924	88.37
Mining				
In the system	4	21,300	1 ,700	79.4
Outside the system	18	24,484	16,040	65.22
Total	22	45,784	33,740	73.47
Industrial				
In the system	27	29,135	21,635	74.25
Outside the system	34	17,084	11,594	67.86
Total	61	46,219	33,229	71.82
Total	226	225,453	184,743	81.9

High Voltage Transmission Lines

Prior to World War II little was done on the construction of high-voltage transmission lines. The little that was accomplished was done from 1930 to 1932, for the electrification of Serbia did not call for the construction of provincial power plants necessitating high-voltage transmission lines. In addition, there were serious difficulties because of variances in voltages and types of current, resulting from disorganized construction of power plants. Intensive activity in the construction of high-voltage transmission lines has taken place in the post-war period. The plan calls for Serbia to be included in a single power system, which will include Yugoslavia's largest hydroelectric and thermal power plants

At the beginning of 1952 Serbia had the following high-voltage transmission lines:

Voltage of High-Voltage Transmission Lines (kv)	Constructed up to End of 1944 (km)	Constructed 1945-1951 (km)	Total Constructed (km)	New Lines Under Construction in 1952 (km)
110 and above	--	441	441	378
60	115	10	125	--
35	426	1,283.7	1,709.7	286
20-25	42	--	42	--
15	290	--	290	--
Total	873	1,934.7	2,807.7	664

Production of Power

In 1951 the production of electric power in Serbia totaled 647,191,000 kilowatt-hours or an average of 96 kilowatt-hours per capita, as compared with 275,010,000 kilowatt-hours or 44 kilowatt-hours per capita produced in 1939.

Compared with the other republics, the production of electric power in Serbia in 1951 was as follows:

Republic	Total Production (1,000 kw-hr)	Production per Capita (kw-hr)
Slovenia	1,001,000	701
Serbia	647,191	96
Croatia	594,000	154
Bosnia-Hercegovina	254,000	93
Macedonia	59,000	49
Montenegro	9,000	23
Total for Yugoslavia	2,564,191	157

The postwar increase in the production of electric power in Serbia has resulted primarily from more complete utilization of existing capacities rather than from establishment of new capacities. In 1939, 17.7 of the maximum installed capacity was utilized; in 1950, 34.2; and in 1951, 36.1 percent.

Production of electric power in Serbia has been as follows (million kilowatt-hours):

	1939	1947	1948	1949	1950	1951
Production	275	375.1	480.7	549.8	608.2	647.2
Index	100	136	175	199	221	235

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Utilization of electric power plant capacities in Serbia in 1951 was as follows:

	Distribution Capacities (kw)	Production (1,000 kw-hr)	Utilized Work Hours in Year	Utilization of Capacity (%)
Thermal power plants	158,951	618,067	3,888	44.36
Hydroelectric power plants	8,352	29,124	3,487	39.8

Production of electric power according to type of plants was as follows (1,000 kw-hr):

	1939	1947	1948	1949	1950	1951
Republic, local, and industrial plants in the system	151,695	236,000	295,000	361,000	404,000	425,137
Index	100	155	194	238	266	280
Local plants outside system	15,600	15,000	25,000	27,000	30,000	30,000
Index	100	96	160	172	192	192
Mining and industrial plants outside the system	107,715	124,185	160,794	161,825	174,200	192,054
Index	100	115	149	150	161	178
Total	275,010	375,185	480,794	549,825	608,200	647,191
Index	100	136	175	199	221	235

Production of electric power in Serbia by area was as follows:

	Production in 1939			Production in 1951			
	Total (1,000 kw-hr)	Kw-hr per Capita	Percent of Participation	Total (1,000 kw-hr)	Kw-hr per Capita	Percent of Participation	Index of Production 1939=100
Total for Serbia	275,010	44	100	647,191	96	100	235
Serbia Proper	160,556	40	58.3	446,139	109	69.9	277
Vojvodina	77,500	46	28	132,167	77	20.4	170
Kosmet	36,954	58	13.5	68,886	88	10.7	186

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The reason for the relatively high production of electric power in the Kosmet was the result of considerable output by the thermal power plant at the Trepca mine. Electric power production in the Kosmet was as follows:

	Production in 1939			Production in 1951			
	Total (1,000 kw-hr)	Kw-hr per Capita	Percent of Partici-pation	Total (1,000 kw-hr)	Kw-hr per Capita	Percent of Partici-pation	Index of Pro-duction 1939=100
Thermal power plant at Trepca mine	34,314	54	92.8	57,033	73	82.7	166
Other plants	2,640	4	7.2	11,853	15	17.3	449
Total	36,954	58	100	68,886	88	100	186

According to a 1949 estimate, Serbia's water power resources constituted 49.5 percent of her total power resources. However, barely 0.1 percent of its water power is exploited for the production of power. The reason for this discrepancy is the fact that prior to the war Serbia had very few hydroelectric plants, and these had very low capacities.

Hydroelectric power production compared with thermal power plant production in 1951 showed that of 647,191,000 kilowatt-hours produced, only 29,124,000 kilowatt-hours were produced by hydroelectric power plants or 4.5 percent of the total production. Compared with Serbia's production of 4.3 kilowatt-hours per capita of hydroelectric power; Slovenia produces 559 kilowatt-hours per capita; Croatia, 98; Bosnia-Hercegovina, 42; Macedonia, 27; and Montenegro, 3.6. The average for Yugoslavia is 83 kilowatt-hours per capita. When hydroelectric plants now under construction are put into operation, hydroelectric power in Serbia will be 54 percent of its total power production. By 1960 hydroelectric power is to be increased to approximately 70 percent, resulting in a bilanced exploitation of Serbia's power resources.

Costs of Electric Power

Costs of electric power in Serbia have followed a constant downward trend in the postwar period. This does not apply to all electric power plants, but refers primarily to republic, local, and industrial plants which operate in a system. Local, mine, and industrial plants which are not part of the system show a continuous rise in production costs and considerably less utilization of capacity. Their current part in production is not dictated by justifiable economic reasons, but rather by the simple necessity for maintaining the existing level of production even to the detriment of profitability.

The cost of production and distribution of electric power produced by plants operating in the system, based on an analysis by the Main Directorate of Electrical Economy of Serbia (Glavna Direkcija Elektroprivrede NR Srbije) was as follows:

Year	Cost per kw-hr (dinars)	Index 1947=100
1947	1.74	100
1948	1.64	94.2
1949	1.61	92.5
1950	1.65	94.3
1951	1.5	86.2

In 1950, costs of electric power produced by Serbian power plants were as follows:

Power Plants	Installed Capacity (kw)	Annual Utilization of Capacity (%)	Production (1,000 kw-hr)	Cost per kw-hr (dinars)
Thermal power Plants				
Belgrade	30,000	54	118,770	1,312
Vreoci	11,600	63	63,723	1,562
Veliki Kostolac	10,500	72	25,975*	1.022
Mali Kostolac	8,000	54.5	28,610	1.618
Zemun	6,400	56.5	31,193	1.671
Novi Sad	5,600	71	34,311	2.112
Zrenjanin	1,050	64.5	5,571	3.082
Subotica	2,500	55	11,766	2.988
Leskovac	1,500	31.4	4,130	4.475
Aleksinac	3,460	58	6,123	5.57

*Only one generator unit was in operation July-December 1950.

Hydroelectric Power Plants				
Vucje	800	100	2,482	0.740
Sokolovica	700	100	3,933	0.656
Sicevo	675	100	4,028	0.628
Ostrovica	660	100	3,228	0.67

Thermal power plants near coal mines such as the Vreoci, Veliki Kostolac, and Mali Kostolac plants had the lowest costs because they did not have to transport coal. At the Mali Kostolac plant, its well chosen site has overcome the

disadvantages of its obsolete equipment and its relatively low utilization of capacity. With the construction of large new hydroelectric plants a considerable decrease in costs of electric power can be expected.

Consumption of Electric Power

Consumption of electric power in Serbia, including all power plants with a capacity of over 100 kilowatts was as follows (these figures are based on the record of the former Savet za energetiku Vlade FNRJ [Council for Power of Yugoslavia]. Since such records are no longer being maintained, the data for 1950 and 1951 are not available.):

Consumption of electric power in Serbia, including all power plants with a capacity of over 100 kilowatts was as follows:

	1947		1948		1949	
Consumers	Consumption (kw-hr)	Percent of Participation	Consumption (kw-hr)	Percent of Participation	Consumption (kw-hr)	Percent of Participation
Electrometallurgy	3,150	1	12,568	3.2	15,088	3.4
Electrochemical industry	6,048	1.9	9,309	2.5	7,996	1.8
Other industries	96,965	30.3	111,010	28.2	132,143	27.8
Mining	93,886	29.4	106,221	27.1	115,460	26.1
Communal enterprises	26,934	8.4	31,729	8.1	32,887	7.4
Public lighting	4,726	1.5	6,096	1.5	7,044	1.6
Motors and equipment in crafts	22,168	6.9	20,607	5.2	24,504	5.5
Agriculture	336	0.1	372	0.1	711	0.2
Lighting in business	17,089	5.3	25,835	6.6	34,987	7.9
Households	45,322	14.2	57,179	14.6	66,449	15.0
Retailers	2,898	1	11,573	2.9	14,657	3.3
Total	319,522	100.0	392,505	100.0	442,926	100.0
Losses	37,988		40,732		50,245	
Total	357,510		433,237		493,171 (1)	

Vlasina Hydroelectric Power System

The basic components of the Vlasina hydroelectric power system are an artificial lake [Vlasina Lake] and four hydroelectric power plants [Vrla I, Vrla II, Vrla III, and Vrla IV] which will be located between the source of the Vrla River and its confluence with the Morava River at Vladicin Han. This system will be 56 kilometers long. The lake will cover an area of 62 square kilometers. Counting canals connected with the lake, the total area covered is 148 square kilometers. The lake will be utilized exclusively by the Vrla I Hydroelectric Power Plant; the Vrla II will utilize the river basin of the Vrla and Bitvrdje Rivers; the Vrla III, the basin of the Masurica and Romanovacka Rivers, and the Vrla IV, the basin of the Jelasnica River.

The water will be collected and utilized as follows:

1. The lake will be located in the valley of what was formerly known as Vlasinsko Blato. Water will be collected directly from the valley, and from neighboring streams which can be effectively utilized. The gentle slopes, width, and length of the valley make it possible to create a lake, utilizing a moderately low waterway channel. Conditions are likewise favorable for maintaining the water level, since the sources of the Vlasina, Vrla, Bozica, and Jerma rivers are at a similar level in the area concerned. Water from these rivers will be collected by gravity canals and brought into the new lake.

2. The altitude of 1,200 meters above sea level, the difference in altitudes, and the waterfall from the lake to the bottom of the Morava River Valley located directly in front, provide Vlasina Lake with an enormous power value.

3. This water will be utilized in four stages by the Vrla plants, which will have a total of ten generator units. Each of the plants will be a diversion type with intakes, which will be under pressure. Each plant can operate independently or as part of a system.

4. Valuable reserves are being created in Vlasina Lake to supply other economic projects which require water. Apart from electrification the system is to supply seasonal electric power at the same time it is supplying water.

5. The system can be further expanded and the supply of electric power and water increased.

Vlasina Lake was created by the construction of a dam which cuts across the Vlasina River bed. The dam is 27 meters high, 250 meters long, and 40 meters wide. The lake is 20 meters deep in some places, and holds more than 80 million cubic meters of water. The underwater area is 9 square kilometers, and the length of the lake is from 800 to 2,000 meters. The total capacity of the lake is approximately 83 million cubic meters.

Water is brought in from the north by two gravity canals; the Cemernik, which circles Cemernik mountain on the left of the Vlasina River; and the Strvna, on the right of the Vlasina River. These canals, which are 25 kilometers long, convey rain and snow water from lakes and streams in the hills. To the south of the lake, the 20-kilometer Bozica canal, which is under construction, is to collect the water and precipitation and convey it through three channels into the lake.

The yearly stream flow into Vlasina Lake will be 61 million cubic meters in a year with average precipitation. The Strvna canal will contribute 11 million cubic meters, the Cemernik, 8, and the Bozica, 20 million cubic meters. The remainder of the water will be supplied from the basin proper.

Since there is no large river or natural lake in this area, and since the water in Vlasina Lake will depend upon precipitation in this area, the question of whether sufficient water will be assured is important.

Two pluviometric stations report that the average annual precipitation is 940 millimeters, with a 0.42 loss coefficient. Although the amount of water which will be accumulated in Vlasina Lake in any given year cannot be accurately determined, because this would require observations over a period of years, it can nevertheless be said that Vlasina Lake and the hydroelectric power plants connected with it will have sufficient water in dry years.

The valley of former Vlasinsko Blato and the beds of the rivers utilized by the lake are composed largely of Paleozoic slate with intruded masses of magma rock. The bottom of Vlasina Lake is composed of slates and products of corrosion of these slates, covered by a layer of peat. The geological conditions for the construction of high dams, waterways, and accumulation basins have been met.

The Vrla I will serve as a link between Vlasina Lake and the following: an open intake canal 600 meters long, a circular tunnel approximately 2 kilometers long into which water from a semiexcavated canal will enter; a lock with four gates, a penstock consisting of two steel pipes laid in an inclined trench, each pipe forking into two branch pipes leading to four turbines, and a tunnel cutting across all the pipes, containing proturbine and ball bearing throttle valves. Thus the average net fall of water into the Vrla I will be 330 meters. The powerhouse is sunk in rock, and is 32,000 cubic meters in area. It will be equipped with four main generators and other installations. The distribution equipment will be located in front of the powerhouse. The plant will have a capacity of 4 x 12,000 [sic] megawatts, and an annual production of 42 million kilowatt-hours.

The Vrla II, being constructed 3.5 kilometers downstream below a series of other installations, includes a new gatehouse, tunnel, water tower, lock, and penstock. Additional installations which are to be constructed are a sluiceway for carrying off alluvium to eliminate clogging in the reservoir, and a machinery building. The latter will be a surface building with two Francis vertical generators. The distribution machinery will be located on a plateau near the machinery building. The plant will have a capacity of 2 x 11.1 megawatts and an annual production of 25 million kilowatt-hours.

The draw and intake of the Vrla III are located on the left bank of the Vrla River, approximately 7 kilometers downstream from the Vrla II. The penstock, machinery room, and the electrical section are to be located in the Masurica River Valley near Masurica. Facilities are under construction to convey water from the Vrla II to Vrla III and to catch water from the Masurica and Romanovacka rivers. The machine building will be a surface building which will house two generator units. The Vrla III will be the headquarters for the Vlasina power system. The capacity of the Vrla III will be 12.8 megawatts in the first stage, and 22.2 megawatts in the second stage of operation. The annual production will be 41 million kilowatt-hours.

The Vrla IV will be located up the Morava River approximately 5 kilometers from Vladicin Han. The plant will have a capacity of 17.6 megawatts in its second stage of operation, and an average annual production of 42.5 million kilowatt-hours.

The water fall between Vlasina Lake and Vrla I is 338 meters; between Vrla I and Vrla II, 152 meters, between Vrla II and Vrla III, 182 meters; and between Vrla III and Vrla IV, 128 meters. The total length of tunnels is about 20 kilometers; canals 52 kilometers; and penstocks, about 7 kilometers; in the second phase of construction, these will be greatly increased.

Three state enterprises are participating in the construction of the Vlasina power system: the site planning enterprise, the investing enterprise which has its supervisory service at the construction site, and the constructor. There are six construction sites.

Upon completion, the ten generator units of the Vlasina power system will have a total annual capacity of 112 megawatts, a little less than the total [prewar?] production of Serbia's thermal power and hydroelectric power plants. The system will produce 150 million kilowatt-hours annually. Electric power will cost .81 dinars per kilowatt-hour at the Vrla I, .76 dinars at the Vrla II, .57 dinars at the Vrla III, and .58 dinars at the Vrla IV. Total annual savings on coal will exceed 64,000 carloads.

If Serbia's other hydroelectric or thermal power plants cannot meet power needs, the Vlasina system will meet them. The Vlasina power system will not consume a single kilowatt-hour of its own production for the system's own needs such as lighting, but will employ power from other power plant networks. The system's production of electric power is intended only for industry, especially in periods of peak industrial demand.(4)

Installations and equipment for the Vrla I and the Vrla II are being supplied as follows: hydraulic equipment by the "Franc Leskosek" Factory of Metal Constructions (Tovarna metalnih konstrukcij "Franc Leskosek") in Maribor, electrical equipment by the "Rade Koncar" Electrical Equipment Factory (Tovarna elektricnih strojeva "Rade Koncar") in Zagreb, and turbines by the "Litostroj" Tito Establishment (Titovi Zavodi "Litostroj") in Ljubljana.

The Vrla I and Vrla II, which are to begin operation at the beginning of 1954, will transmit power through Nis, Krusevac, and Svetozarevo, and will connect with the Kostolac system. Power from the Vlasina system will be supplied to the Copper Rolling Mill (Valjaonica bakra) in Sevojno near Titovo Uzice, to the Cable Factory (Fabrika kablova) in Svetozarevo; to numerous industries and mines, and to light agricultural processing factories which will be built in Toplica, Sumadija, and other parts of Serbia. A transformer station will be built in Doljevac on the border of Niski, Leskovacki, and Dobricki srezes, to provide electric lighting to villages in these sreres, and to other villages in southern, eastern, and western Serbia.

Construction on the Vlasina power system was begun in 1946. Much construction was done by Yugoslav youth. In 1952, more than 10,000 young people's labor brigades were engaged in this work. Workers' brigades and groups from other mass organizations also cooperated. In addition to the voluntary work which totaled several hundred million dinar's worth, Yugoslavia has invested 8 billion dinars in this project (5)

[Appended figure shows cross section of the Vlasina Power System including reservoir, canals, and rivers.]

Zvornik Hydroelectric Power Plant

In electric power production the Zvornik Hydroelectric Power Plant will be second (Jablanica on the Neretva in Croatia will be first) in Yugoslavia. Its expected annual output of 406 million kilowatt-hours will be one and a half times greater than Serbia's total prewar power production. The Zvornik will supply power to western Serbia, Belgrade, part of the Vojvodina, and part of eastern Bosnia. The copper and brass rolling mill in Sevojno, the zinc and copper electrolytic plant (Elektroliza cinka i bakra) in Sabac, which are under construction, and the "Zorka" Chemical Combine (Hemiski kombinat "Zorka"), which is being enlarged, will require large amounts of electric power. These plants and many others under construction will depend upon electric power from the Zvornik plant. The plant will also play a major role in the Podrinje mining area.

When the Zvornik and Vlasina systems are completed, there will be a change in the ratio between thermal and hydroelectric power plant production; a decrease in the cost of electric power, increased electrification of villages, savings of approximately 700,000 carloads of coal, and the release of coal for industrial use.

The Zvornik plant will be relatively cheap to construct because little excavation and few canals and tunnels will be required. Power from the Zvornik plant will be less costly because of savings in construction costs. One kilowatt-hour produced by the Zvornik plant will cost .115 dinars per kilowatt-hour compared with .197 at the Jablanica plant, and .68 [sic] dinars at the Vrla I plant.

When the Zvornik plant is completed, cooperation will be established between it and thermal power plants now in operation or under construction. The thermal power plants will be supplemented by the Zvornik plant when they reduce production because of (1) coal shortages in the winter and spring months, (2) transportation difficulties, (3) reduced production in the mines, or (4) increased demands for coal by sugar factories and households. During these months the Drina River is high and the Zvornik plant can assume a maximum load. In the summer months when the Drina River is lower, the thermal power plants will be able to assist the Zvornik plant. The thermal power plants and the Zvornik Hydroelectric Power Plant will be united in a single system. This system will include Vreoci, Lukavac, Kolubara, and other thermal power plants, and will extend to Valjevo, Sabac, Novi Sad, Titovo Uzice, and Belgrade. Eventually the system is to extend throughout Serbia, so that power can be supplied when necessary by the Zvornik plant to Subotica, Pristina, or Pirot.

Construction on the Zvornik plant began in April 1948, but was preceded by preparatory work involving land surveying and planning. The Drina River was chosen because its hydraulic power potential is 1.6 million kilowatts, the highest in Yugoslavia, the river is entirely in Yugoslavia; and it is centrally located. The plan for utilization of the central portion of the Drina River from Zvornik to Visegrad calls for the construction of five large hydroelectric power plants on the river. Priority was given to the construction of the Zvornik plant because it will be located at the lowest point of the Drina River's lower course and because it will be centrally located near villages, towns, and communications, thus the transportation of material to the site will be facilitated. When the power plant is completed, the site will provide the most economical point for the transmission of electric power.

The narrowest spot, which is approximately 1.5 kilometers from the bridge between Veliki Zvornik and Mali Zvornik, was selected for the dam site. This site is almost a ravine, formed by the Drina River cutting into the mountain. The construction site was established on the relatively narrow strip of land between the bridge and the ravine. As a result, a portion of Mali Zvornik had to be torn down and its people resettled.

The plan called for the Zvornik plant to be put into operation by the end of 1951, but construction difficulties were encountered. The extent of the project may be judged from the following:

Preparatory Work (cu m)

Excavation of alluvium	100,000
Excavation of rock	60,000
Concrete used	30,000
Wood used	2,000

Main Construction Work

Excavation of alluvium	220,000 cu m
Excavation of rock	160,000 cu m
Concrete	220,000 cu m
Lining	80,000 sq m
Reinforcing iron	3,000 tons

The concrete alone required about 320,000 cubic meters of gravel and sand, and about 7,000 carloads of cement.

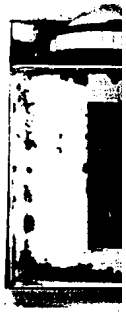
The lack of equipment and the scarcity of specialized personnel slowed down the work considerably. However, work has been progressing rapidly since the following have supplied modern equipment: the "Ivo-Lola Ribar" Machine Tool Factory (Fabrika teskih alatnih masina "Ivo-Lola Ribar") in Zeleznik, the "Djuro Djakovic" Railroad Equipment Factory (Industrija lokomotiva, strojeva i mostova "Djuro Djakovic") in Slavonski Brod, the "3 Maj" Shipyard (Brodogradiliste 3 Maj") in Rijeka, and others. Equipment at the work site includes a cable crane, gravel separator, cable dredger, cable railway, concrete plant, and similar installations. Installations for the excavation, washing, and separation of sand and gravel are located on the opposite bank of the Drina River below Divic, in the area which will be the bottom of the future artificial lake. The sand and gravel are scooped up by large dredging machines, raised 20 meters, passed through a washer, sorted, and lowered into bunkers. A cable railway transports the material to the receiving station which is located on the opposite bank above the dam. Here the cargo is emptied into stockpiles according to type. Then the gravel and sand are transferred mechanically to the concrete plant located below the receiving station. The concrete plant consists of large concrete mixers. Cement is stored up to 10 meters high in 8 bunkers. The bunkers are filled and emptied automatically, the cement being stored in them to the proper temperature. Finished concrete is transported by cable cars to the dam. The cement plant can process 1,200 cubic meters of gravel daily.

With the construction of the Sabac-Zvornik standard-gauge railroad, transportation difficulties have been solved.

The Zvornik project employs more than 2,500 blue-and white-collar workers. The workers have mostly been recruited from Zvornik and neighboring villages. More than three fourths of them have signed one-year contracts. Approximately 150 have contracts for more than a year. Manpower is available in sufficient quantity except for a scarcity of foremen and machinists.

Insufficient and irregular supplies of electric power have presented considerable difficulties. In 1949 the pumps taking water out of the dam bed had to stop operation more than once because of lack of electric power. Each time it was necessary to dismantle machinery and lighting installations to prevent them from being flooded. Electric power is now supplied by the Vreoci and Tuzla plants, and an auxiliary plant at the site.

All preparatory work has been completed and construction has begun on the dam. By the end of March 1953 24,000 cubic meters of concrete were used in the dam, 8,500 cubic meters of concrete for the machinery building, and 29,600 cubic meters of concrete and 30,000 cubic meters of earth for the dam bed. For installations on the right bank of the river, 74,000 cubic meters have been excavated, of which 62,000 cubic meters were rock.



Equipment

Equipment and installations for the new power plant including generators, turbines, locks, and similar equipment are on order with the "Rade Koncar" factory in Zagreb, the "Litostroj" factory in Ljubljana, and the "Franc Leskosek" factory in Maribor. Some of the installations and equipment are already arriving and will soon be installed. A crew of 20 specialists has been sent to the construction site and is engaged in work preparatory to installation.

Dam and Artificial Lake

The Drina River bed will be completely closed by a 20-meter high and 166-meter long dam. On each bank of the dam, a machinery building which will contain two generator units is under construction. The average water fall will be 20 meters. Each of the four generator units will have a capacity of 21,000 kilowatts. The average annual output from these generator units will be 406 million kilowatt-hours

The dam will have eight spillways to take care of excess water. In addition the dam will have a controlled-crest spillway 32 meters long to regulate the discharge. To protect the intake to the turbines and to protect the locks from getting clogged by deposits, the dam will be equipped with 4 sluiceways, and the banks will be forested. On the right bank of the river, in Serbia, a log chute 125 meters long and 2.5 meters wide will be built. A fish ladder will be constructed on the left bank, the Bosnian side.

An artifical lake, 25 kilometers long and in some places 2 kilometers wide, will result from the construction of the dam. The lake will be one of Yugoslavia's largest, almost equal to Lake Ohrid. The artificial lake will have a capacity of 23 million cubic meters. More than 800 hectares of land will be submerged including 680 hectares of cultivated land, about 50 square kilometers of highways, and the village of Divic.

The Zvornik Hydroelectric Power Plant will cost 2.13 billion [dinars] at lower uniform prices. Of this amount, 83 million will be used for expropriation, 70 million, for planning and consolidation of the area; 251 million, for preparatory work, 1,046,000,000, for main construction, and 680 million, for equipment.(6)

Criticism of the Shortage of Electric Power in Serbia

[Following are excerpts from an article by J. Raicevic and D. Markovic in Borba, 9 Jan 54.]

Belgrade and Serbia have insufficient electric power. Numerous cities are frequently without electricity, and industry is occasionally obliged to stop operations because of power shortages The Bor mine reports a loss of half a million dinars resulting from a break in the supply of electric power. Consequently, a group of deputies asked the Executive Council (Izvrsno vijece , at a meeting of the Serbian People's Assembly (Narodna Skupstina Srbije) on 30 December 1953, about the status of electric power and the measures undertaken to solve this acute problem

No reply was given, but the deputies were informed that an explanation would be provided at the following meeting scheduled for the latter part of January 1954

It is astonishing that the Executive Council was not prepared to reply at the time the question was asked, inasmuch as the electric power crisis in Serbia has been an issue for over 6 months.

Meanwhile the public, which is continually being offered varied official and nonofficial explanations for the electric power shortage, remains confused.

In June 1953 the press published an optimistic analysis of the Federal Institute for Planning (Savezni Zavod za planiranje), which stated that electric power demand in 1962-1963 in Yugoslavia would total approximately 8.2 billion kilowatt-hours, while the plan calls for electric power plants to supply approximately 11 billion kilowatts [-hours?]. If this estimate is accurate, either it is unnecessary to speed the construction of new projects, or they should be delayed until later.

Eleven days before the meeting of the assembly, Voja Lekovic, vice president of the Executive Council, expressed a completely different point of view. In an interview with Politika, he stated that the basic reason for shortages in electric power was lower power capacities. The conviction that there is insufficient electric power is not new but has been a topic of discussion for years. He said that "we [members of the planning board?] pointed out long ago that 1953, 1954, and 1955 would be difficult years for Yugoslav industry because there would be a shortage of electric power. Meanwhile, our warnings were not understood, but it was maintained that Serbia had more electric power than necessary." Lekovic affirms that similar views exist today. It is his opinion that electric power is the greatest major problem to be solved in Serbia. He stated, "Electric power has become a bottleneck and a major political issue. The solution of the electric power shortage can be achieved only by the construction of large power plants on the Drina River such as the Dubravica and Crna Voda plants."

Lekovic believes that the solution lies in the construction of new power plants, especially since the following new factories are to be put into operation: the rolling mill in Sevojno, the cable factory in Svetozarevo, the zinc electrolytic plant in Sabac, the cement factory in Popovac, the Majdanpek mine, and other projects which will consume vast amounts of electric power. In the meantime, the investment plan for Serbia indicates that in 1962-63 Serbia will have a surplus of 136 million kilowatts, without counting the Crna Voda plant, whose construction is being insisted upon.

There is a demand for new plants, while those under construction have not yet been completed.

All plans since 1947 have called for the Ovcar Banja, Raska, Medjuvrsje, Vrla I, Vrla II, and Kostolac power plants to be put into operation no later than 1953. To date not one of these plants has been completed. Difficulties have been encountered, but similar difficulties were solved in Slovenia and Croatia where a number of large hydroelectric plants are already in operation.

Were finances a problem? Apparently not, for Serbia has been getting ample funds for capital investment.

No one so far has come up with an answer. The public has no other recourse than to assume that the only reason for this situation is the unfinished hydroelectric power plants.

The Zvornik, Vrla I, Vrla II, Ovcar Banja, Medjuvrsje and Raska plants would supply about 619 million kilowatt-hours, compared with a total 740 million kilowatt-hours production in 1953 in Serbia.

How long will external reasons be sought and new investments demanded for key projects which should have been completed long ago?

Why should there be discussion in Serbia on the construction of new hydroelectric plants? New power plants are necessary in the planning stage, but at present they obscure the basic issue: why is there no current?(7)

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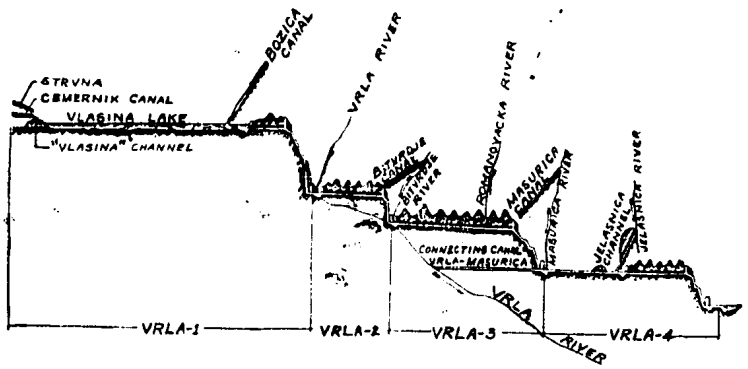

CROSS SECTION OF THE VLASINA POWER SYSTEM INCLUDING RESERVOIR, CANALS, AND RIVERS

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